

# Climate change, worker safety, and health

CLIMATE CHANGE & HEALTH

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# About me

I am an environmental and development economist and currently a post-doctoral scholar in the Center on Food Security and the Environment at Stanford University.

I am affiliated with the labs of David Lobell and Marshall Burke. In September I will begin as an Economist in the Development Economics Research Group at The World Bank.

I received my PhD from Harvard University where I was a Harvard Environmental Economics Program pre-doctoral fellow and a PhD affiliate of Evidence for Policy Action as well as an EPA STAR Fellow.



# *In Sweltering South, Climate Change Is Now a Workplace Hazard*

Workers laboring outdoors in southern states are wrestling with the personal and political consequences of a worsening environment.

# Workers are people

**The fundamental health threats to workers from climate change are the same as those faced by everyone else.**

- Heat exposure
- Dehydration
- Chronic kidney disease
- Complications from exposure to air pollution
- Increased exposure to vector borne diseases
- Increased exposure to weather extremes

There are some new work specific hazards:

- Exposure to new chemicals
- New, potentially hazardous, physical processes

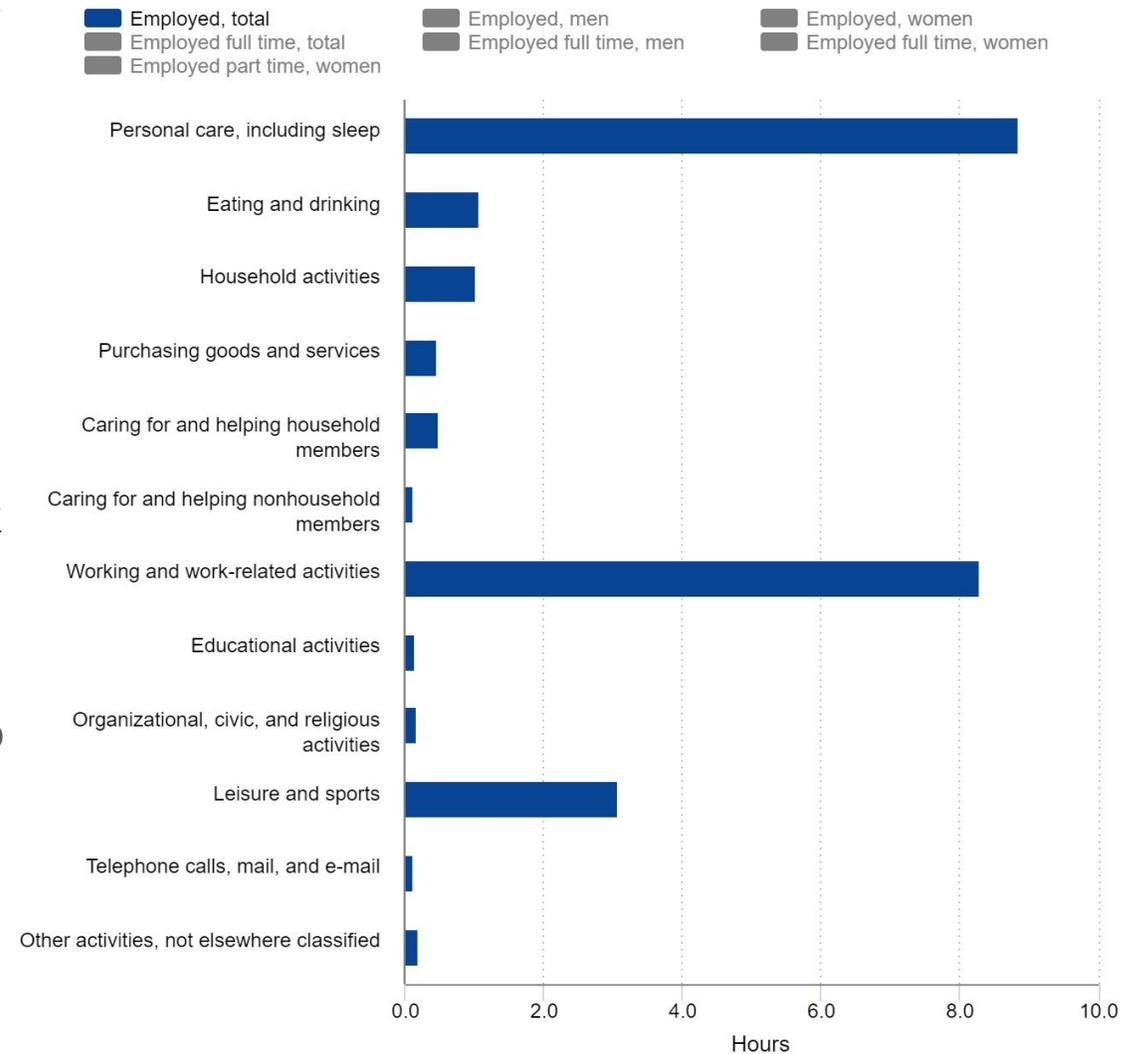


# What makes work different?

There are at least three reasons why the impacts of climate change on workers specifically matter.

1. For many people their place of work will be where they spend the vast majority of their time.
2. Workers often have little control over their work environments.
  - 80% of American workers cannot choose where they work (Maestras et al. 2015).
  - Many workers will be limited in their ability to engage in adaptive behavior.
  - Firms might not want to.
3. Some work environments exacerbate existing hazards of climate change.

Average hours per day spent in selected activities on days worked by employment status and sex, 2019 annual averages



Data for men employed part time do not meet publication criteria.  
Hover over chart to view data.  
Source: U.S. Bureau of Labor Statistics.



# Workplaces can exacerbate existing hazards

- U.S.: 66% of workers without a BA are exposed to extreme temperature at work (RAND 2017).
- 67% of US workers have jobs that require substantial physical exertion at least some of the time.
- Globally there are 1.1 billion agricultural workers, 200 million construction and landscaping (World Bank, 2017).



# Workplaces are dangerous even apart from climate change

- In 2019 there were 2.8 million nonfatal injuries at places of private employment reported to the BLS.
- Nearly 900K of these required the injured party to miss at least 1 day of work.
- Manufacturing was the leading industry.
- Compare this to only 423 deaths directly attributable to heat from 1992-2006 (CDC).

Chart 1. Incidence rate of total recordable cases, private industry, 2010-19

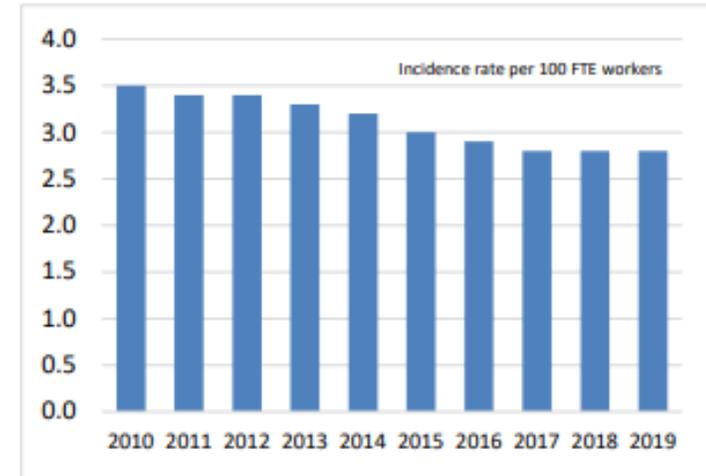
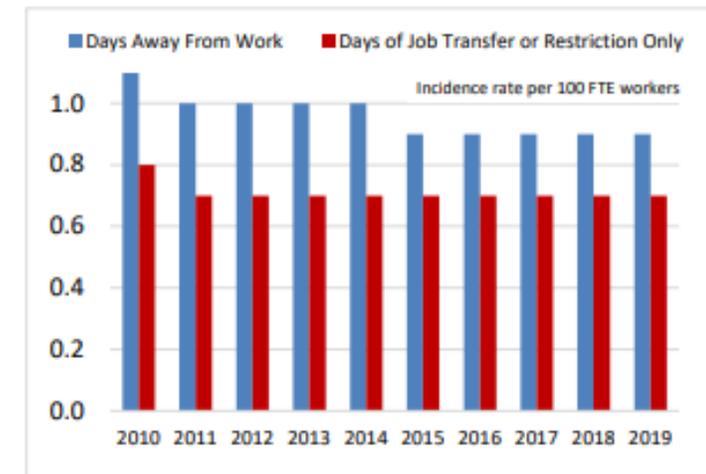


Chart 2. Incidence rate of days away from work cases and job transfer or restriction only cases, private industry, 2010-19



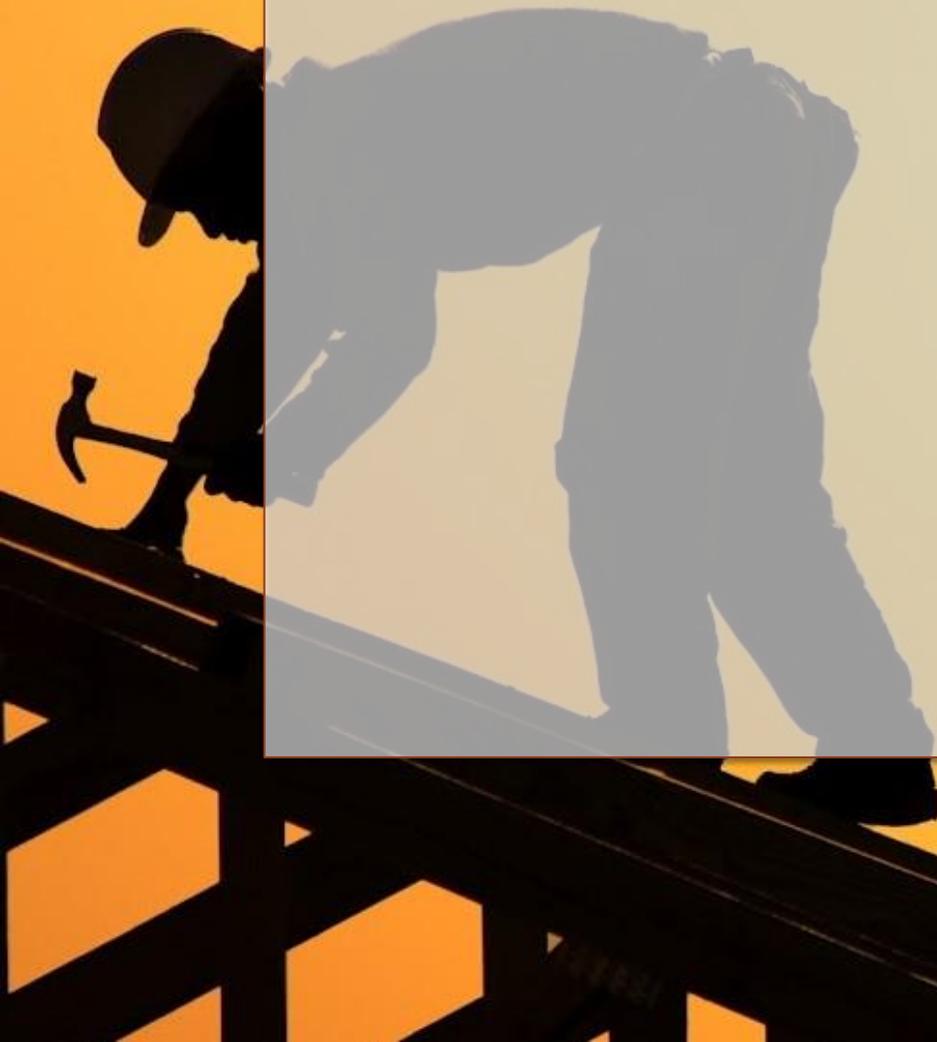
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# What is the magnitude of non-heat workplace climate health risks?

## Vector based diseases

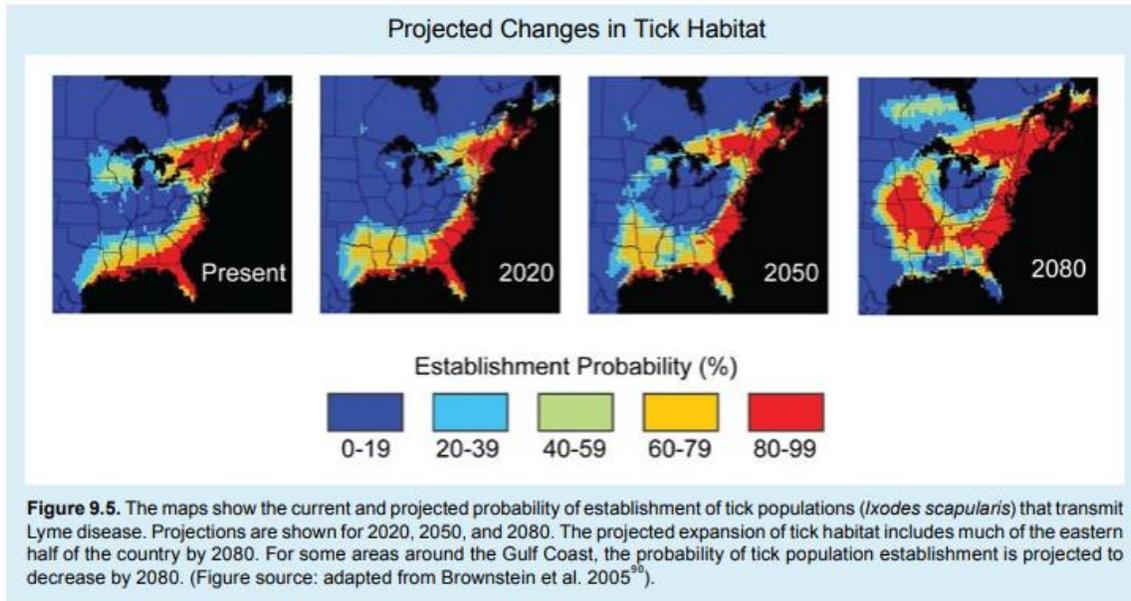
- About 35K lyme disease cases total per year
- Other vector borne diseases identified by the NCA as likely to increase due to climate change are not an appreciable threat in the US

## Extreme Weather

- Around 20% of injuries are directly related to extreme weather. But many of these are related to cold, which are likely to decline (Dillender 2019)

## Chronic Kidney Disease

- Not yet a major problem in the United States.
- It is a major threat in some Central American countries.



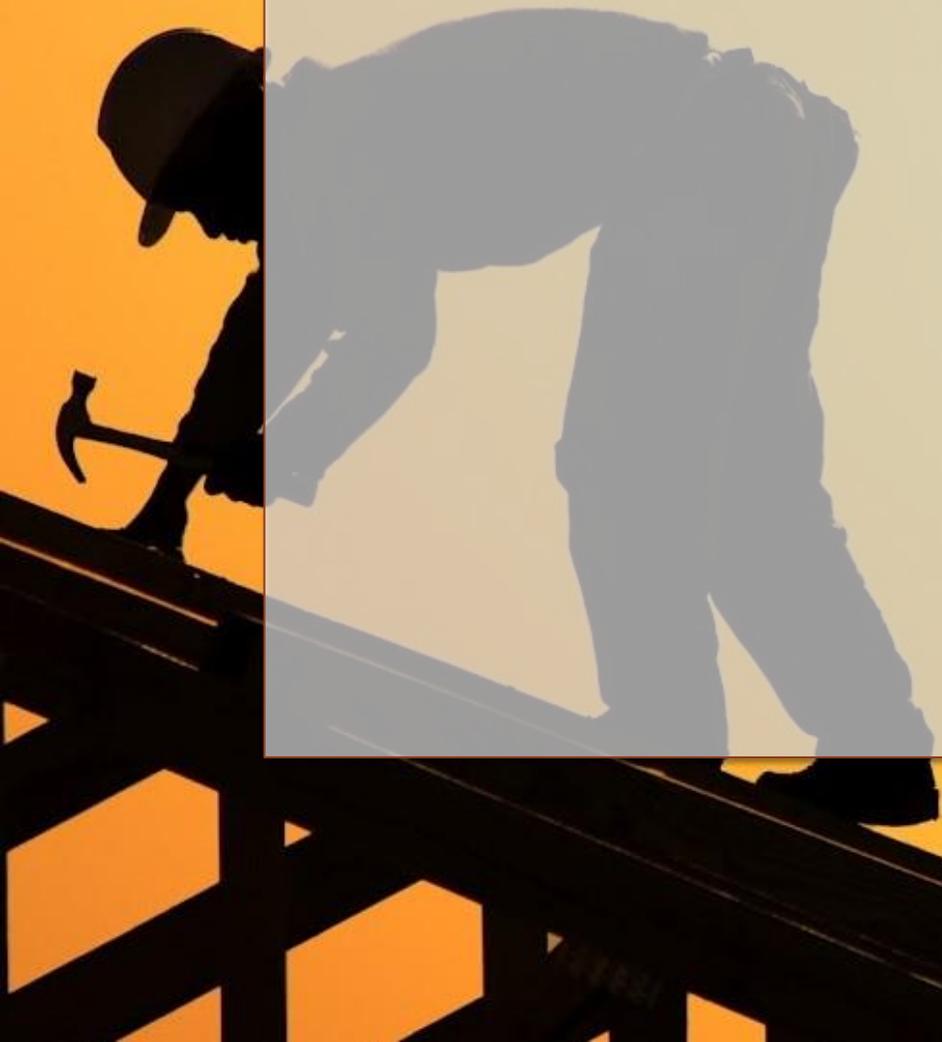
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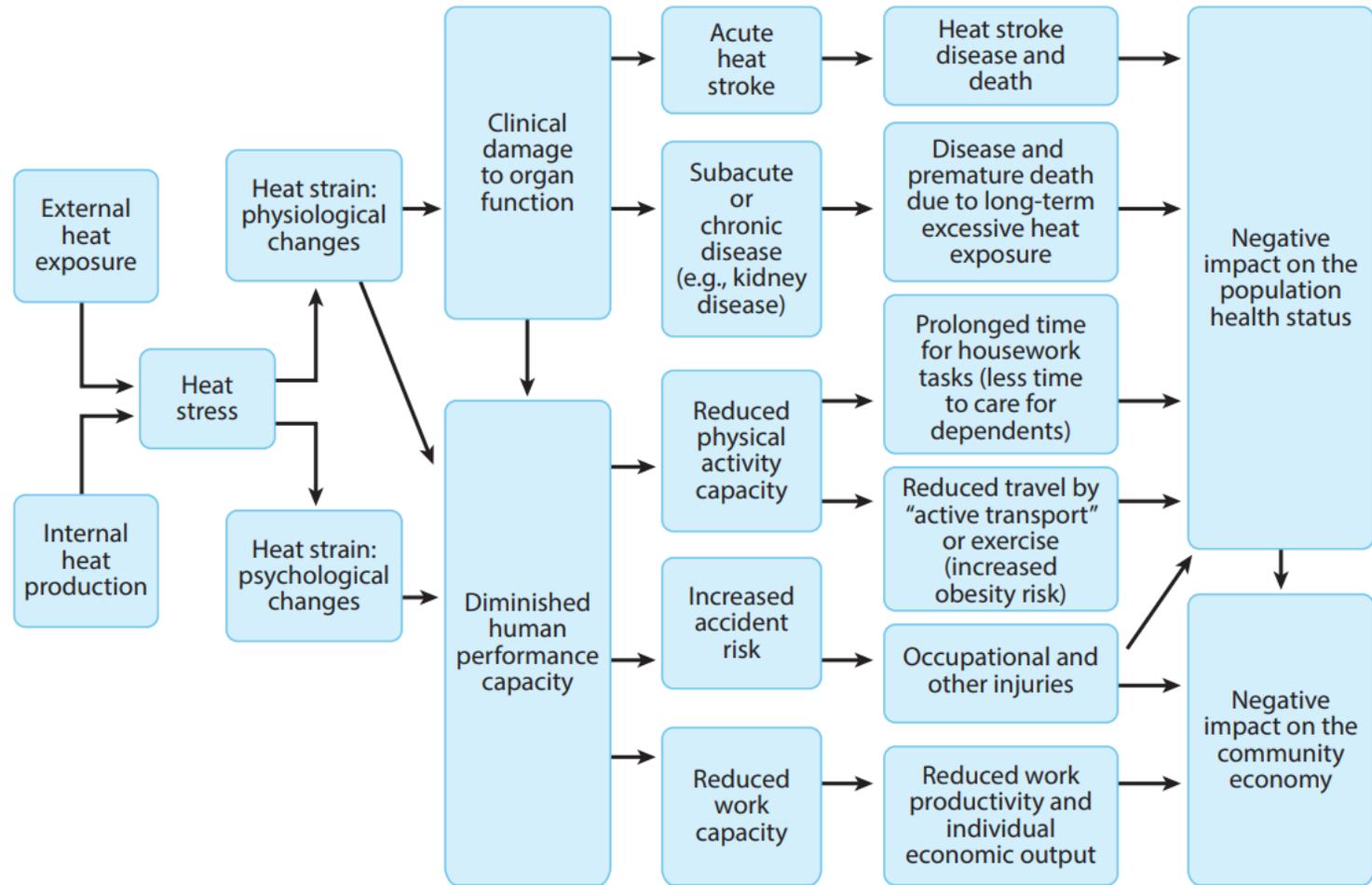
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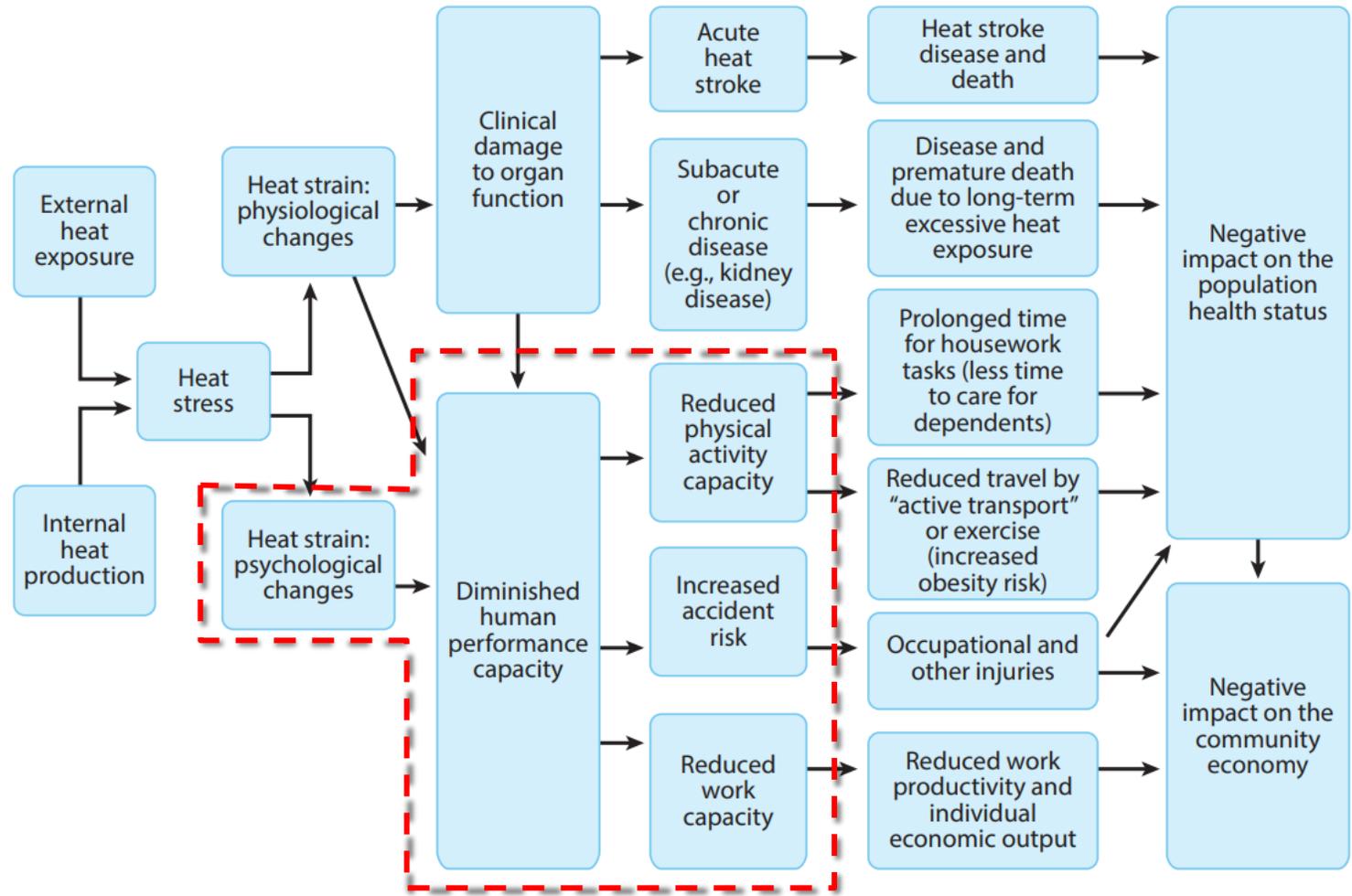
# Pathways of heat's impact



**Figure 1**

Framework of causal pathways for direct heat effects on working people (45).

# Pathways of heat's impact

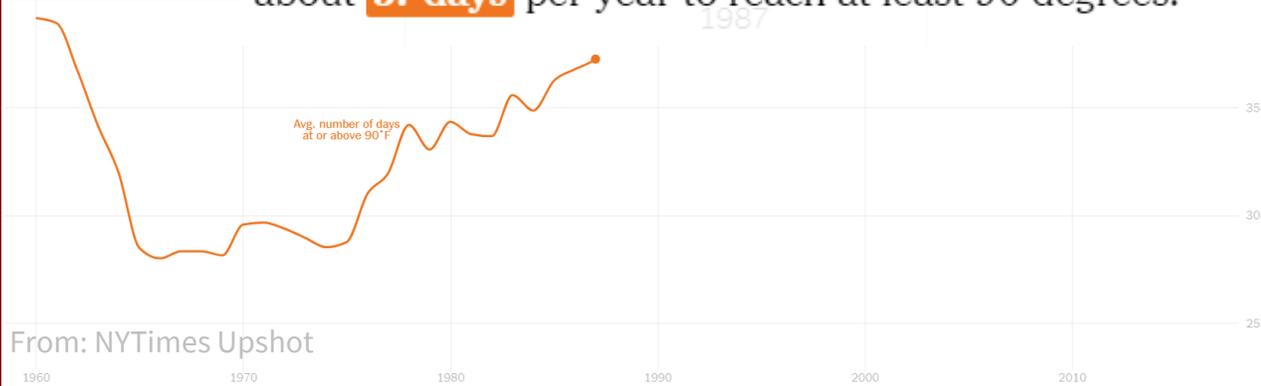


**Figure 1**

Framework of causal pathways for direct heat effects on working people (45).

# For workers in the US heat exposure is likely to dominate

When you were born, the Atlanta, Georgia area could expect about **37 days** per year to reach at least 90 degrees.



From: NYTimes Upshot

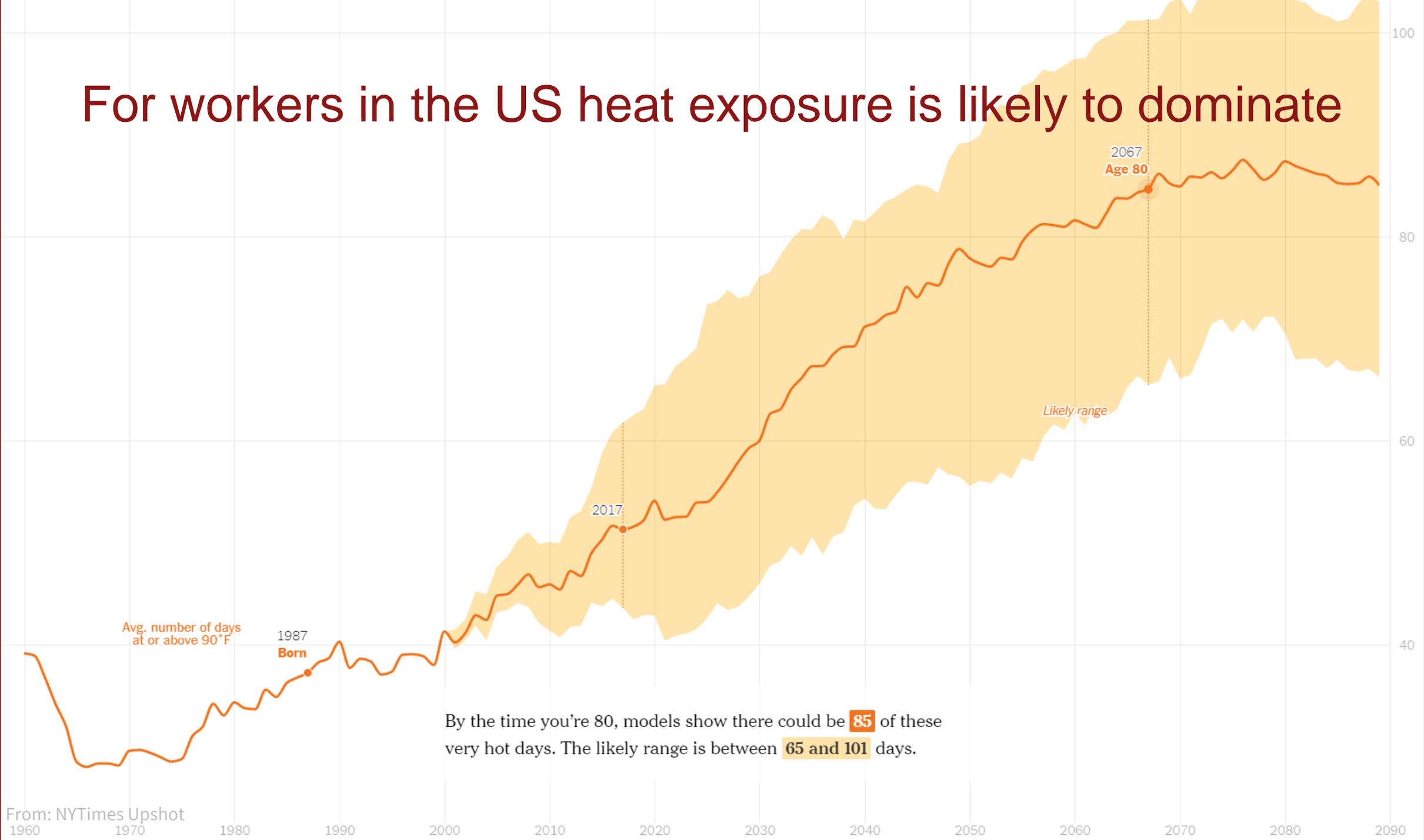
# For workers in the US heat exposure is likely to dominate



Today, the Atlanta, Georgia area can expect **51 days** at or above 90 degrees per year, on average.

From: NYTimes Upshot

# For workers in the US heat exposure is likely to dominate



Avg. number of days at or above 90°F

1987 Born

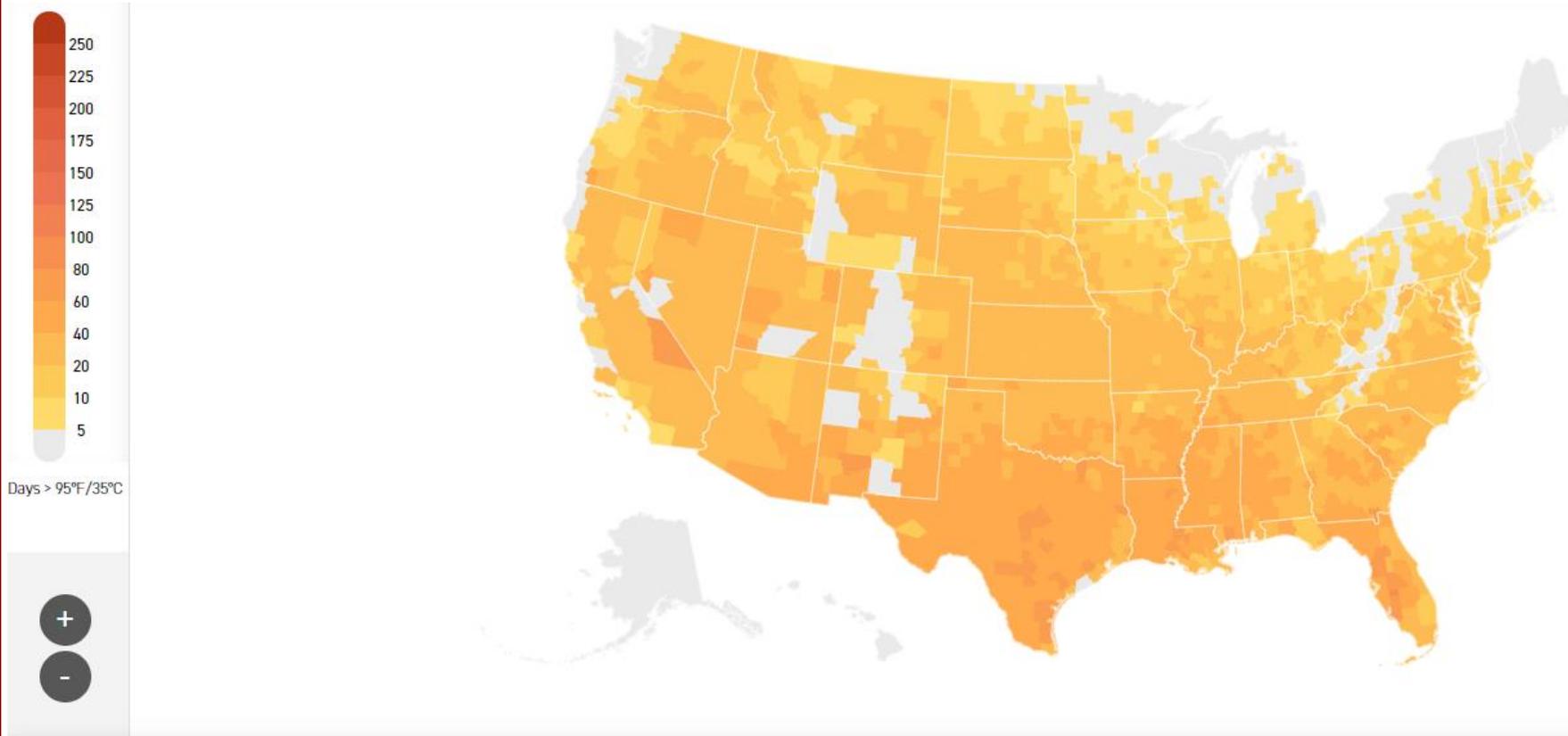
2017

2067 Age 80

Likely range

By the time you're 80, models show there could be **85** of these very hot days. The likely range is between **65 and 101** days.

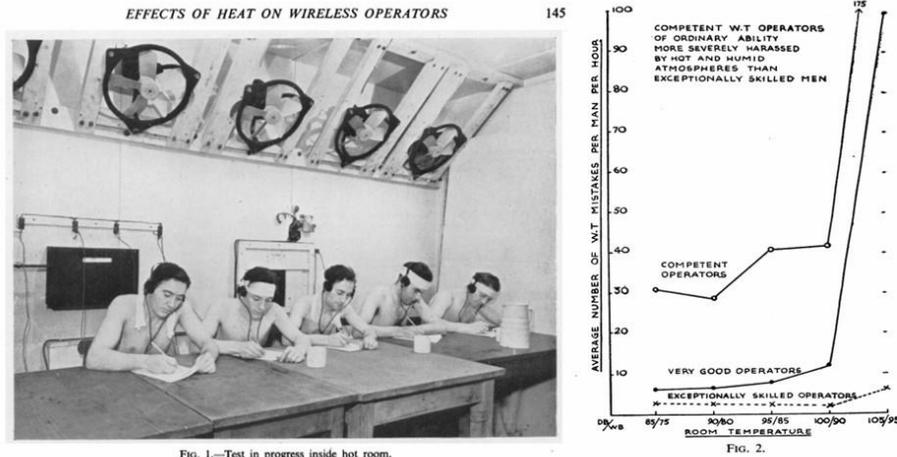
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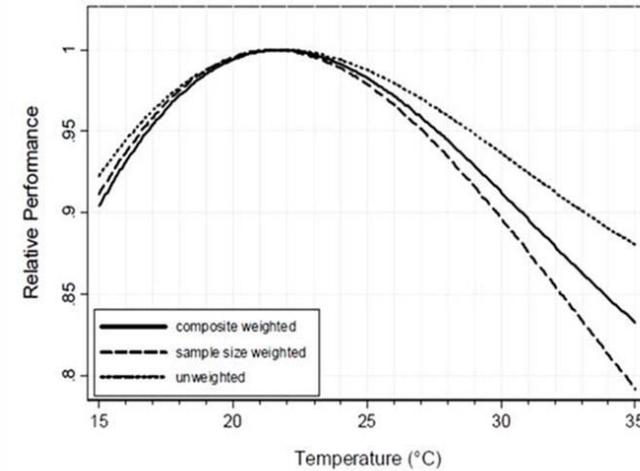
Additional days above 95F that each county in the US will experience by 2080-2099 under the RCP4.5 scenario (UChicago Climate Impact Lab).

# We should think of heat primarily as a multiplier

Heat reduces attention, concentration, and focus.



(Mackworth, 1947)



(Seppanen et al, 2008)

This exacerbates the risks in already dangerous occupations and workplaces.

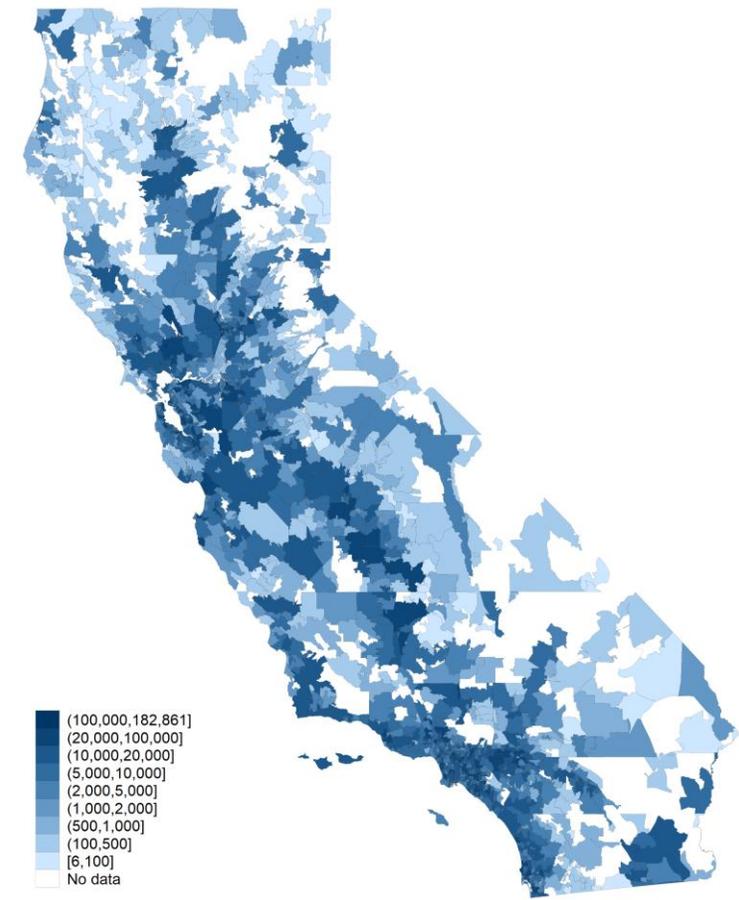
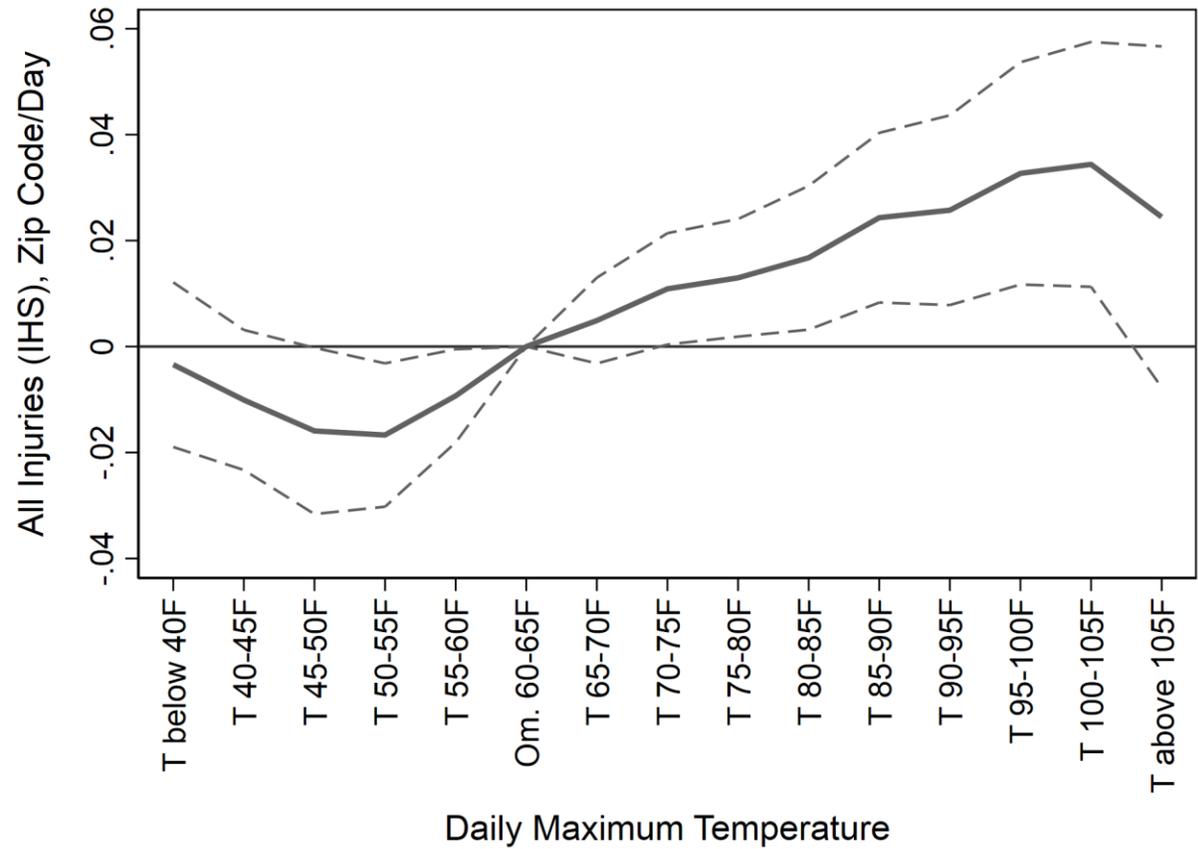


# What is the magnitude of the multiplier effect?

We use 12 million injury claims from the universe of worker compensation claims in California from 2001-2017 to answer two questions.

1. What is the relationship between temperature and workplace safety and injuries?
2. What is the role of policy in facilitating adaptation and worker protection?

# Worker injuries increase on hot days



Heat and workers

Stanford University

# Unsurprisingly, hot days increase heat related injuries more...

Heat related injuries – heat syncope, heat rash, heat stroke, etc.

- A day between 90-95° F increases heat related injuries by 276% relative to the average day.
- A day over 105° F increases heat related injuries by 760% relative to the average day.
- We find no effect for days between 80-85° F

Non-heat related injuries – “fall, slip, or trip”; “moving part of machine”; “lifting”; etc.

- A day between 80-85° F increases injuries by 3.2% relative to the average day.
- A day between 90-95° F increases injuries by 4.5% relative to the average day.
- A day over 105° F increases injuries by 6.1% relative to the average day.

## ...but base rates mean non-heat injuries are a bigger danger

On average there were 850 heat related injuries per year from 2000-2018 in California.

There were roughly 645,000 non-heat related injuries per year over the same time-period.

Our estimates imply that roughly 4,500 of those were due to heat raising injury risks.



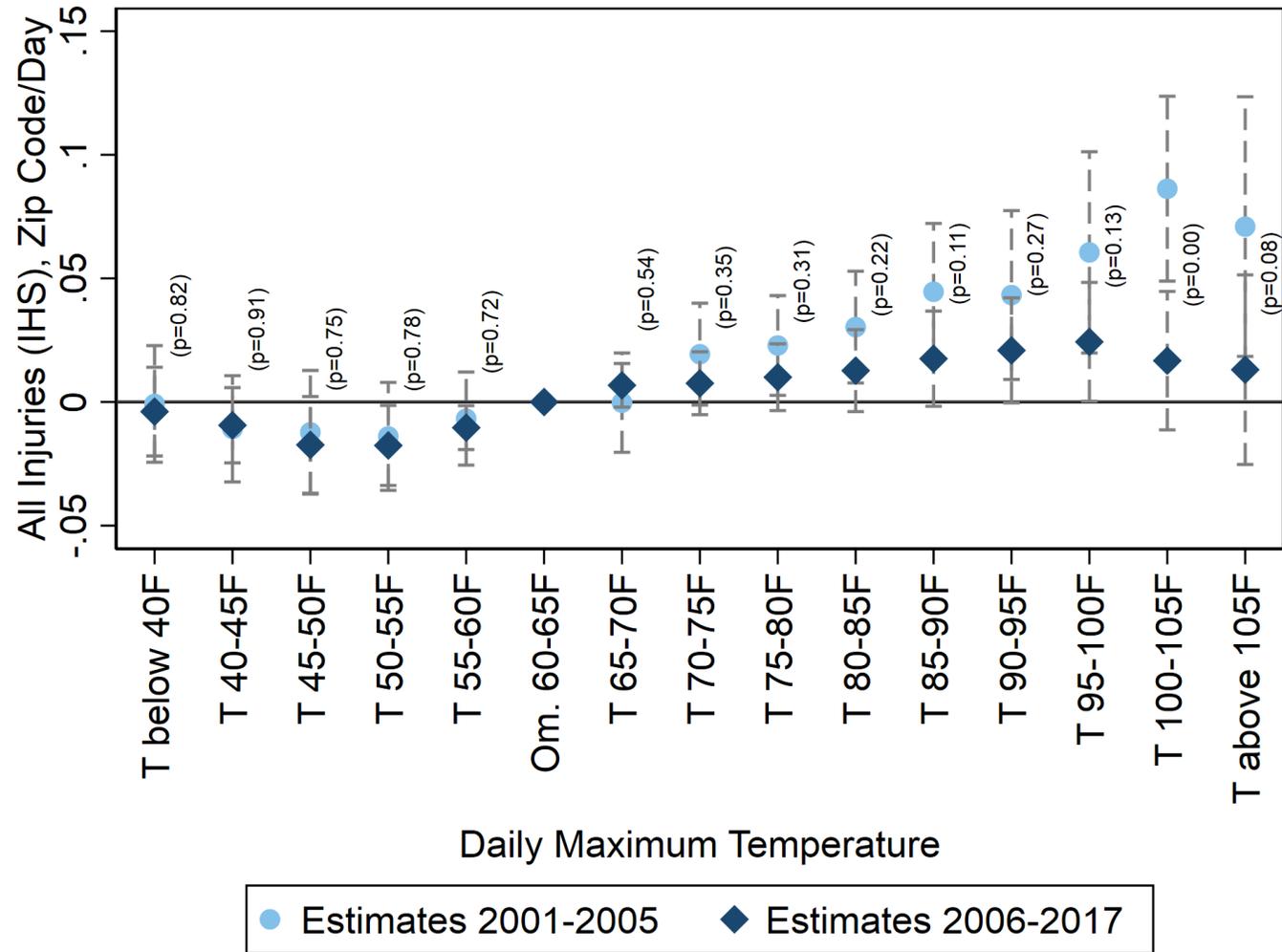
# What does this mean from a policy standpoint?

California is one of only three U.S. states that currently have mandatory heat standards for workers.

- When the California standard was implemented in 2005 it was the only mandatory standard in the country.



# The policy appears to have reduced injuries



FE: Zip-Month (Pre/Post), County-Year-Month - SE Clusters: County, Year-Month

It also seems to have solved some negotiating challenges between workers and firms.

- The policy does not appear to have led to reductions in wages.
- And may have led to increases in employment.

What about the impact of pollution?



# What about the impact of pollution?

PERSPECTIVE



## The changing risk and burden of wildfire in the United States

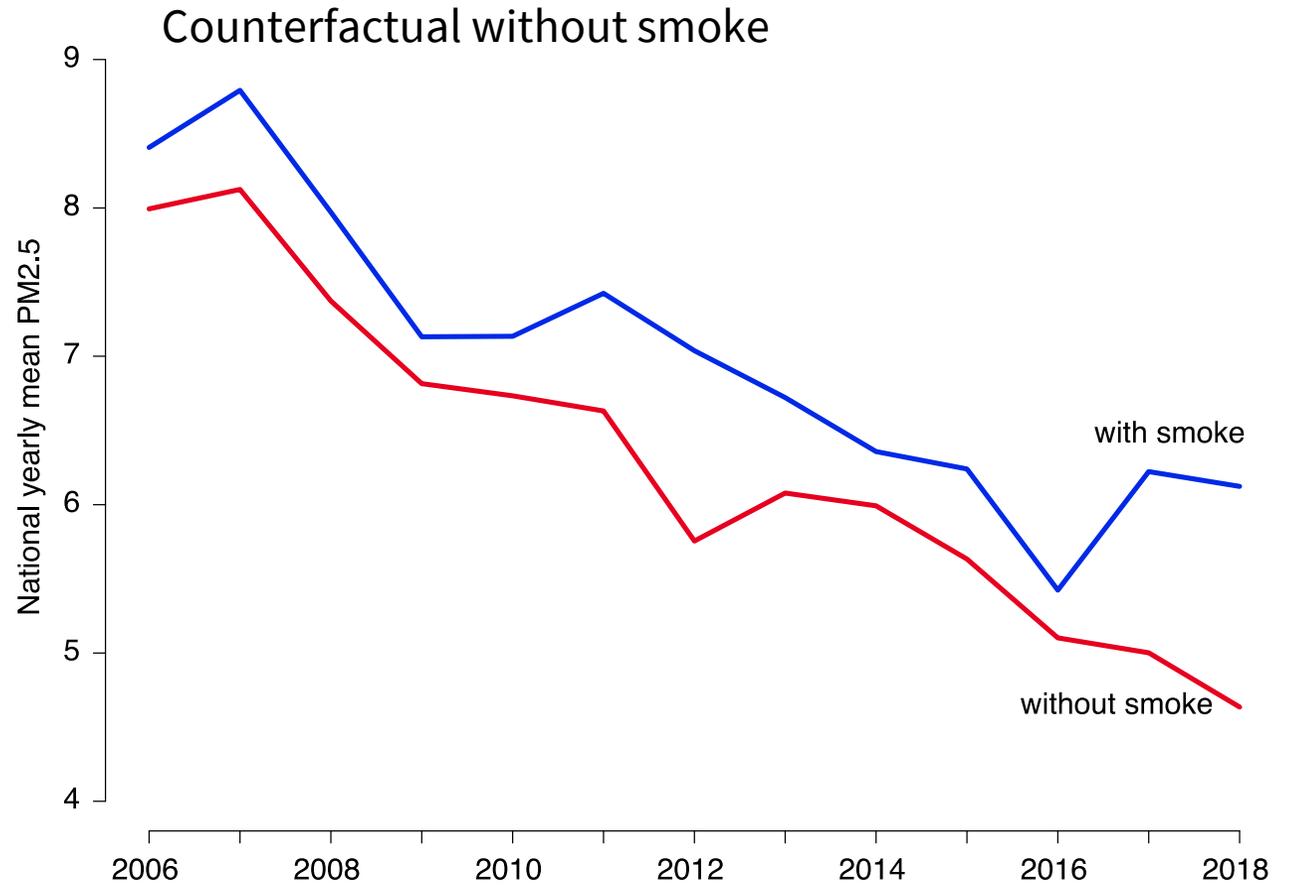
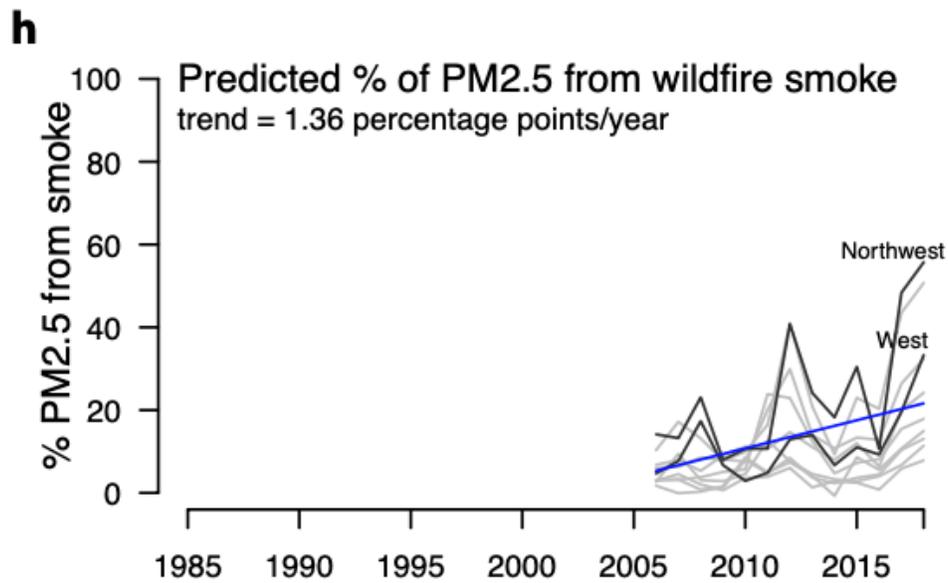
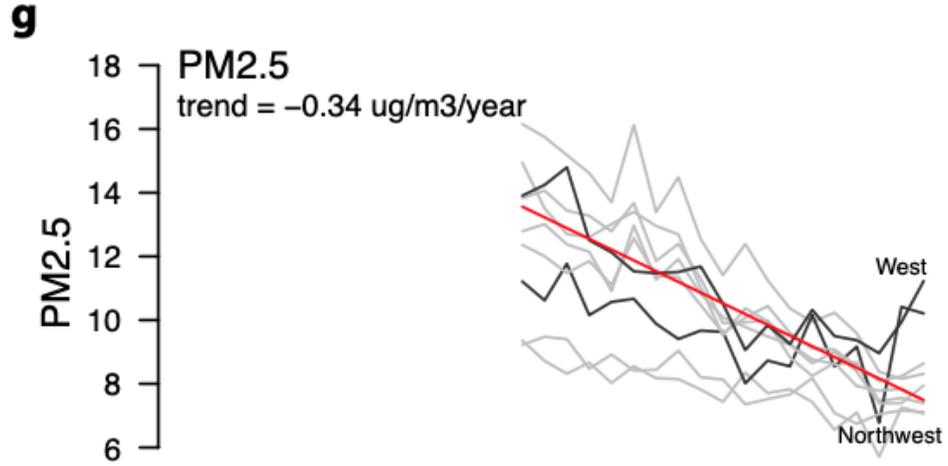
 Marshall Burke, Anne Driscoll,  Sam Heft-Neal,  Jiani Xue,  Jennifer Burney, and  M...  
[+ See all authors and affiliations](#)

PNAS January 12, 2021 118 (2) e2011048118; <https://doi-org.stanford.idm.oclc.org/10.1073/pnas.2011048118>

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# Smoke contribution to overall PM2.5

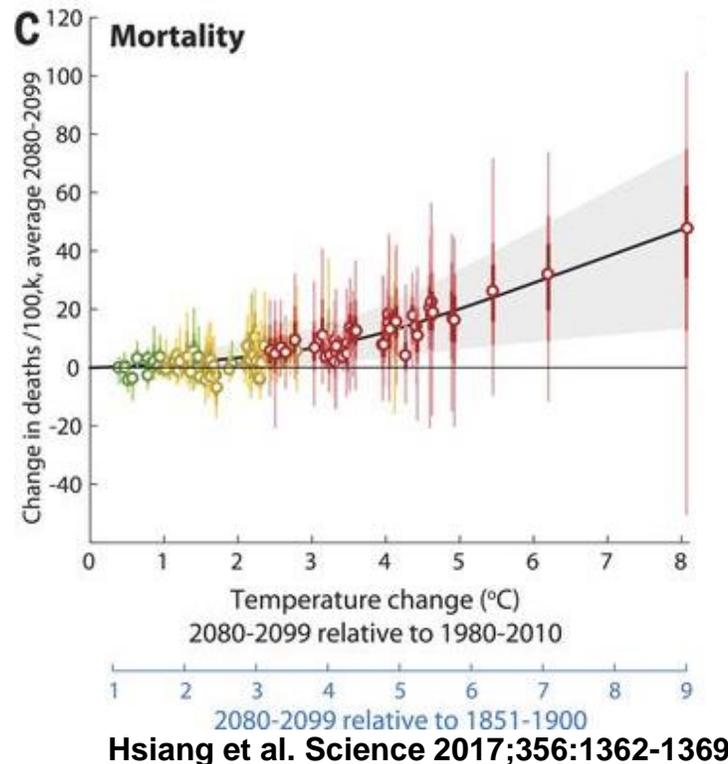


# Wildfire vs heat

Projections suggest 50-200% increase in area burned by end of century.

Burke et al 2020: 50% wildfire increase → 9-20 deaths per 100k old age

Compare: heat-related mortality (ACP 2015; Hsiang et al 2017):



**By far the largest source of economic damage in the US!**

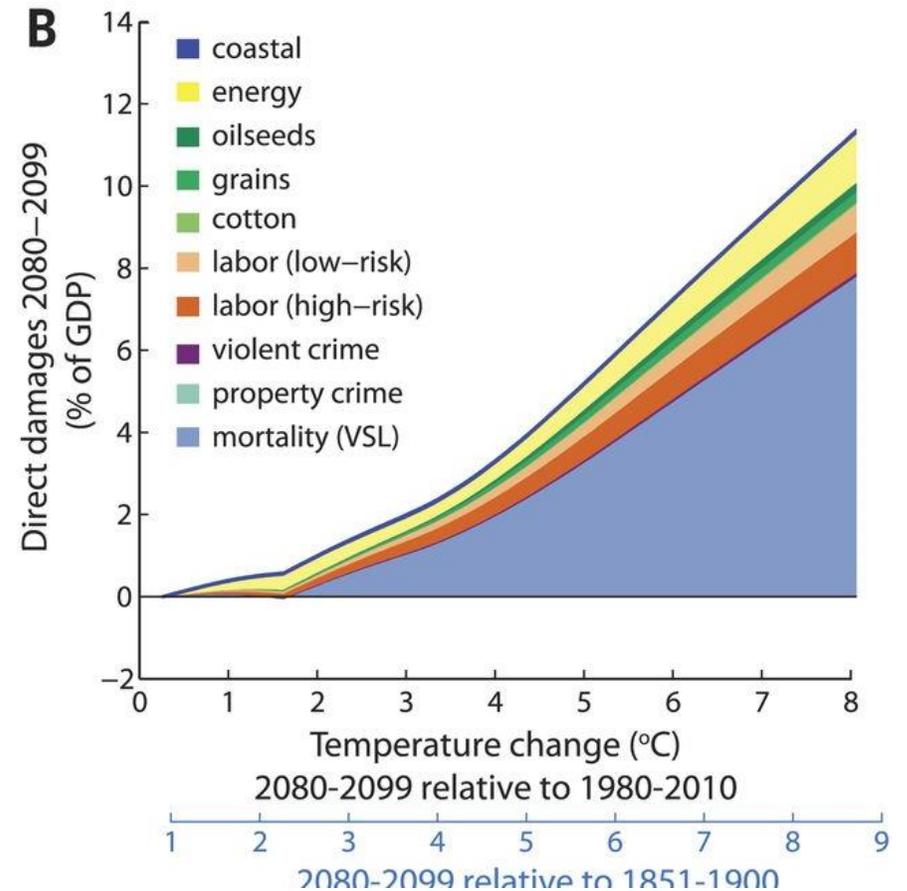
**+4C --> 20 per 100k deaths**

# What does this mean for social cost of carbon?

Mortality is the largest source of economic damages from climate change in the United States.

Most estimates of the social cost of carbon do not fully capture our understanding of the mortality costs of climate change as of 2017.

That understanding, in turn, does not account for the increased risk of workplace injury due to heat.



# Lessons

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The impacts of climate change on worker health are not fundamentally different than the impacts on non-workers. But the work environment can exacerbate these impacts.

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Climate change, and heat in particular, will act as a multiplier; increasing the existing risks in a given workplace. This indirect effect is likely to have substantially larger welfare impacts than any direct impacts.

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The consequences of climate change for worker safety have not yet (substantially) been incorporated into thinking about policy responses to climate change or calculations of the social cost of carbon. Doing so would likely raise these costs significantly.